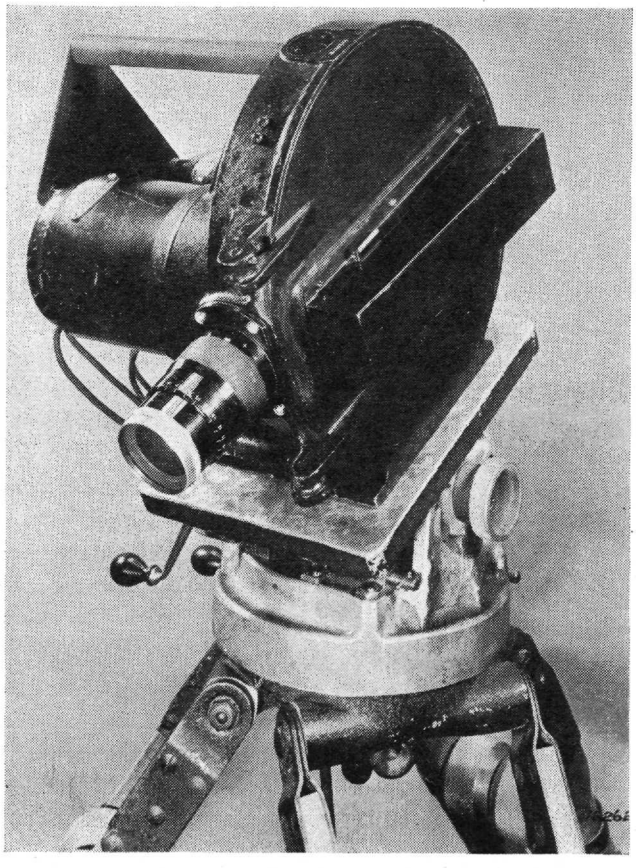
HIGHER SPEED CAMERA

By GORDON SHISLER

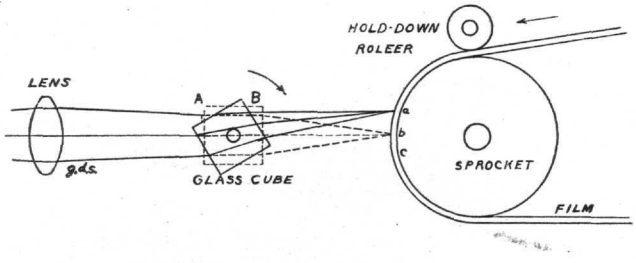
Photos Courtesy of Bell Telephone Laboratories



Prepared for Action

(The author wishes to acknowledge the cooperation of W. Herriott of Bell Telephone Laboratories in preparing this article.)

One of the important applications of photography to industry and yet, strangely enough, one which has received little publicity is that of slow-motion photography. Although this type of photography is not by any means new, all of us being familiar with its use in athletics, its applications to engineering have only recently been discovered. Mechanical movements, which to the human eye appear as a blur, or are too rapid to be followed, can easily be analyzed by photographing them with a high speed camera and then projecting the film at a much lower rate of speed.

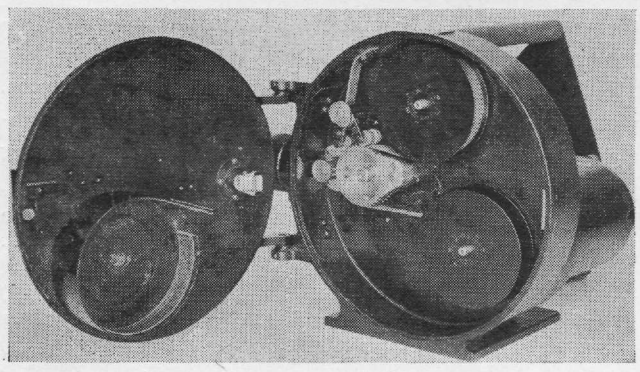


General Principles

The designing of such a camera was not easy. Consider, for example, the difficulty in arranging a shutter

of sufficient speed to follow the motion of an electric buzzer vibrating at several hundred vibrations per second. This problem was overcome by Bell Telephone Laboratories who dispensed with a complicated shutter and substituted a small cube of glass which rotates at a high rate of speed. When taking 4000 pictures a second, it is necessary for the cube to rotate 1000 revolutions per second, each one quarter revolution allowing one complete exposure on the film. The cube rotates on a ball bearing shaft driven by a set of spur gears from a small motor. A sprocket, attached directly to the drive shaft of the same motor, rotates at 12,000 revolutions a second. This sprocket drives the film. Sixteen millimeter film is used in the camera, although it is of slightly different design than that used in standard cameras. The loaded film spool is placed on the upper spindle, and the film threaded under a guide roller onto the main sprocket. From the main sprocket it goes to the take-up spool driven by a second motor.

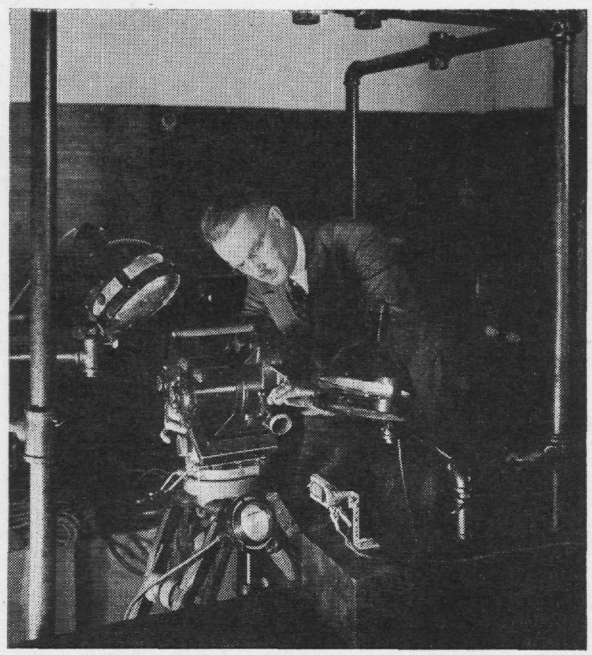
The method by which the picture is recorded on the film may be seen in the diagram. Converging light rays from the lens strikes the face of the cube as shown



The Insides Revealed

at "A". They are then refracted to the opposite face and to the film at "a" where they form an image. Since the cube and sprocket are each connected to the same motor, they are synchronized automatically. Thus, while the sprocket is turning from "a" to "b" and finally to "c", the cube is turning also. The image, in this way, is kept accurately focused on the film. The length of exposure is decreased by speeding up the motor and allowing each element of the film to remain before the lens a shorter length of time. The exposure may also be varied by an aperture on each face of the cube. Attached to the hinged door of the camera is a hooded ground-glass screen for use as a finder. Lenses of various focal lengths may be mounted directly on the front of the camera.

Intense light sources are required because of the short exposure period. Portable lighting units, employing both carbon arcs and tungsten lamps, are used for this purpose. Intensity of the light varies between 10,000



W. Herriott and the Camera

and 500,000 foot candles according to the type of subject being photographed. Liquid filters are used to absorb the heat radiated by the lamps.

Action photographed by the camera at the rate of 4000 pictures a second, is then projected at the normal rate of between sixteen and twenty-five per second. To the person viewing the picture, the action appears to be happening at only 1/250 of the original speed. The possibilities of such an instrument are boundless. It may be used by automotive engineers to study vibration and rates of combustion; it is useful in aeronautics for the study of air flow; or it may be instrumental in ballistic studies. At the Laboratories, the device is used as a visual in problems associated with design, manufacture, and performance of telephone apparatus. The high degree of portability which has been achieved both in the camera and lighting equipment makes it suitable for application in almost any problem requiring the aid of high speed photography.

ACKNOWLEDGMENT

We are grateful to the editors of "Fortune" magazine for the illustrations appearing in the article on fluid drives appearing in the last issue. Mr. Segna will be pleased to answer questions if you have some. They may be answered in print, or by mail, if a stamped and addressed envelope is included.

The cut of William Murdock appearing on the cover last month was supplied by American Gas Journal.

First Father: "So you cured your son of his wildness by an operation?"

Second Father: "Yes, I cut off his allowance."